NASA Aeronautics Research Mission Directorate

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Aeronautics Research Mission Directorate

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Outline

- ARMD Principles and Organization
- Overview of ARMD Structure
- Mission Accomplishment
- Observations

ARMD Mission and Principles

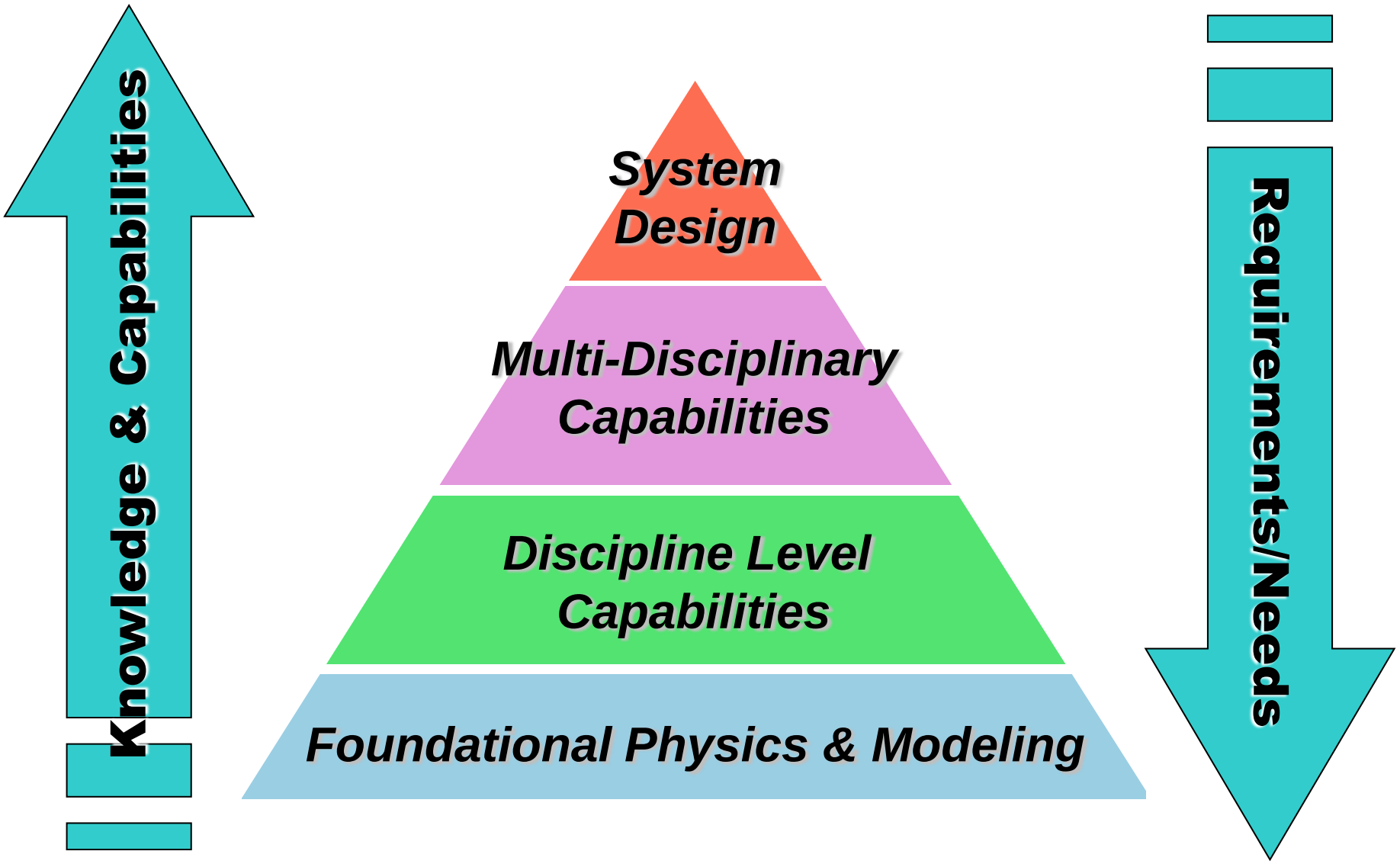
The Overarching Mission of NASA's Aeronautics Research Mission Directorate (ARMD):

- To advance U.S. technological leadership in aeronautics in partnership with industry, academia, and other government agencies that conduct aeronautics-related research.
- ARMD supports the Agency's goal of developing a balanced overall program of science, exploration, and aeronautics, and ARMD's research plans also directly support the National Aeronautics R&D Policy and accompanying Executive Order 13419.

The Three Core Principles of ARMD:

- We will dedicate ourselves to the mastery and intellectual stewardship of the core competencies of Aeronautics for the Nation in all flight regimes.
- We will focus our research in areas that are appropriate to NASA's unique capabilities.
- We will directly address the fundamental research needs of the Next Generation Air Transportation System (NextGen) in partnership with the member agencies of the Joint Planning and Development Office (JPDO).

Research Philosophy



Research Hierarchy - Chevron Example

One success story: result of a balanced pipeline

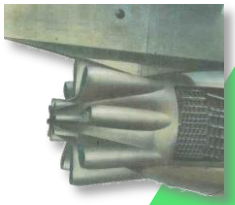
Technologies & Capabilities

Requirements/Needs

System Design

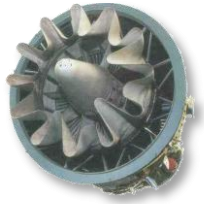
2001-2005

Multi-Discipline Capabilities



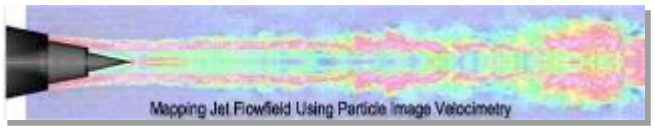
1996-2000

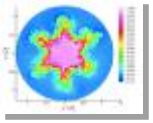
Discipline Level Capabilities

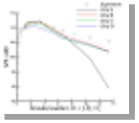


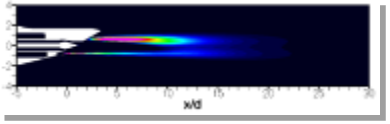
1994-1996

Foundational Physics & Modeling

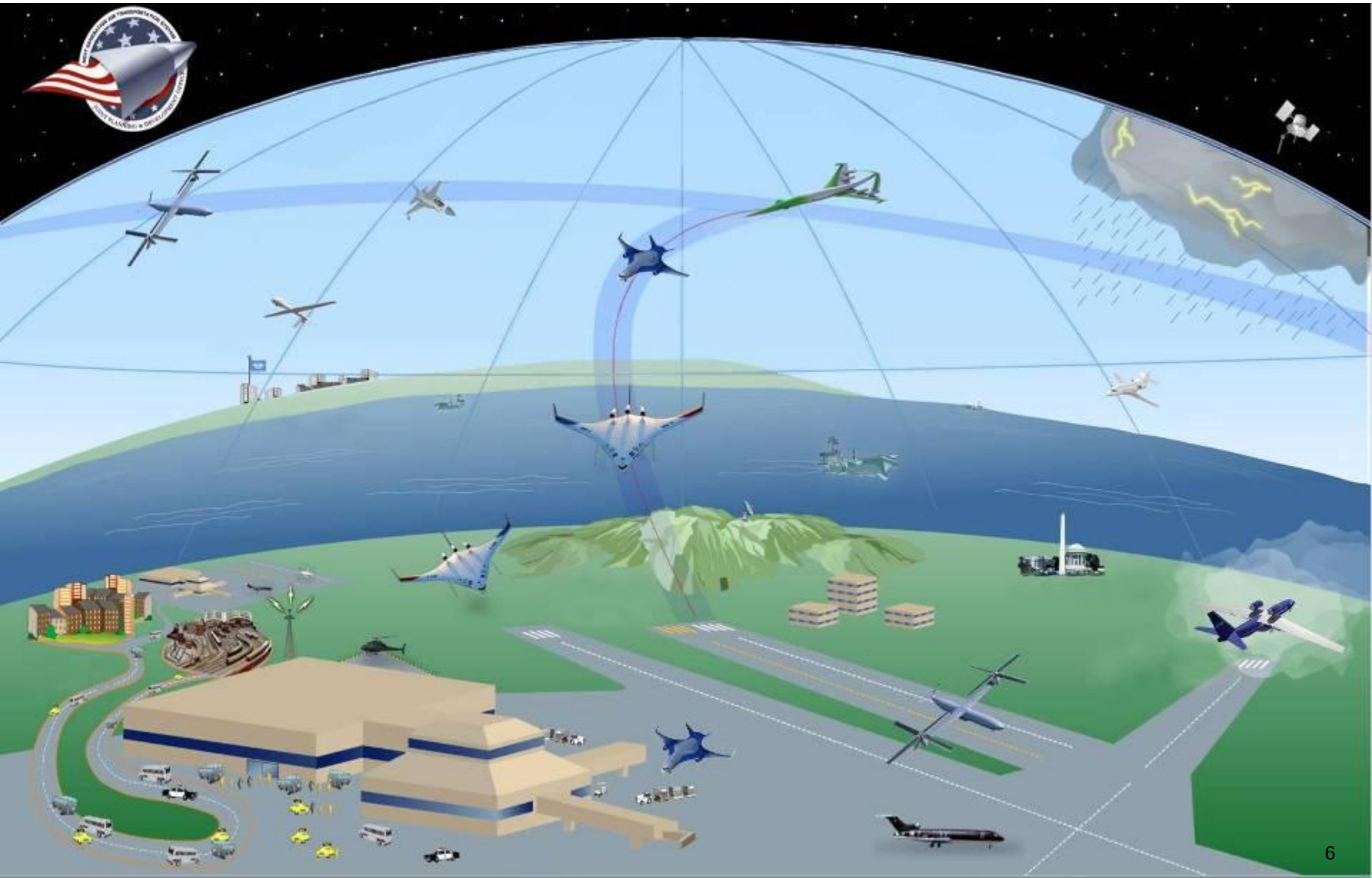




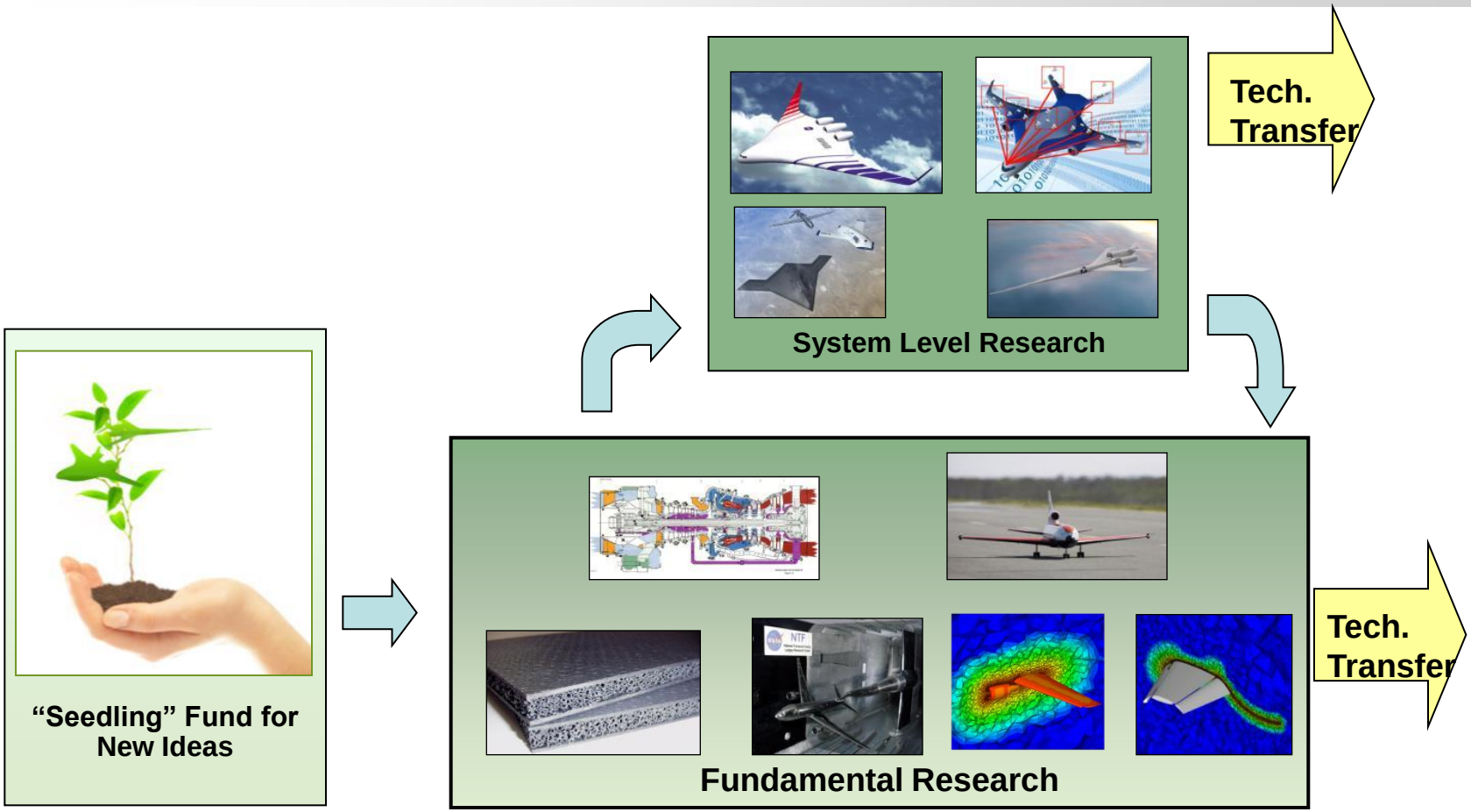




Next Generation Air Transportation System (NextGen)



NASA Aeronautics Investment Strategy



Enabling "Game Changing" concepts and technologies from advancing fundamental research ultimately to understand the feasibility of advanced systems

NASA Aeronautics Programs in FY2010



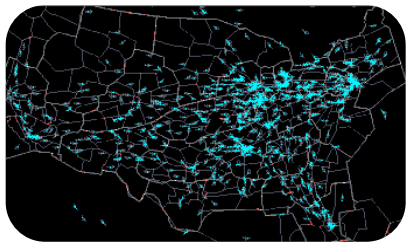
Fundamental Aeronautics Program

Conduct cutting-edge research that will produce innovative concepts, tools, and technologies to enable revolutionary changes for vehicles that fly in all speed regimes.

Integrated Systems Research Program

Conduct research at an integrated system-level on promising concepts and technologies and explore/assess/demonstrate the benefits in a relevant environment





Airspace Systems Program

Directly address the fundamental ATM research needs for NextGen by developing revolutionary concepts, capabilities, and technologies that will enable significant increases in the capacity, efficiency and flexibility of the NAS.


Aviation Safety Program

Conduct cutting-edge research that will produce innovative concepts, tools, and technologies to improve the intrinsic safety attributes of current and future aircraft.




Aeronautics Test Program

Preserve and promote the testing capabilities of one of the United States' largest, most versatile and comprehensive set of flight and ground-based research facilities.

ARMD FY10 President's Budget

($ Millions)	Enacted FY08*	FY09**	FY10	FY11	FY12	FY13	FY14
Aeronautics Total	$511.4	$650.0	$507.0	$514.0	$521.0	$529.0	$536.0
Aviation Safety	$66.5	$89.3	$60.1	$59.6	$59.2	$61.7	$62.5
Airspace Systems	$100.1	$121.5	$81.4	$82.9	$83.9	$87.3	$88.3
Fundamental Aeronautics	$269.7	$307.6	$228.4	$230.0	$233.6	$239.0	$245.9
Subsonic Rotary Wing	30.8	38.8	26.1	26.1	26.3	27.4	27.9
Subsonic Fixed Wing	119.7	153.1	101.6	103.7	105.4	107.3	110.8
Supersonic	53.0	55.5	40.6	40.0	40.7	42.0	42.8
Hypersonic	66.2	60.3	60.0	60.2	61.1	62.3	64.4
Aeronautics Test Program	$75.1	$131.6	$74.7	$77.1	$77.2	$76.6	$78.8
Integrated Systems Research	$0.0	$0.0	$62.4	$64.4	$67.1	$64.4	$60.5

* FY08 reflects the September Operating Plan including augmention ($60M)

**FY09 reflects the Enacted Appropriation Augmentation ($53.5M) plus the Recovery Act ($150M)

How ARMD Accomplishes its Mission

ARMD

- Program Leadership Primarily at HQ
- Projects distributed across Centers

In-House Workforce

- Matrix Organization (ARMD Program and Center Line Organizations)
- Primarily distributed across four research centers (LaRC, GRC, ARC, and DFRC)
- Supported by Service Support Contractors (WYEs)

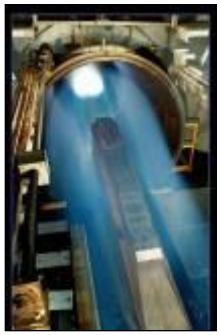
Partners

- Other Mission Directorates
- Space Act Agreements
- NASA Research Announcements
- Other Procurement Mechanisms (e.g. RFP)
- Other Government Agencies
- Foreign Collaborations

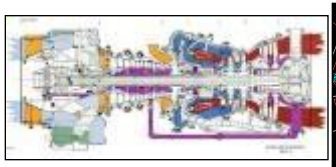
Facilities

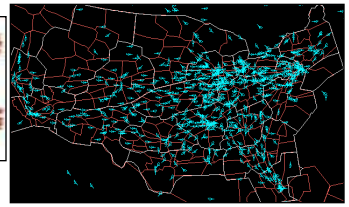
- Includes ground test, flight experiment and computational capabilities
- Coordinated with other Agencies (esp. DoD)

Technology and Knowledge Transition

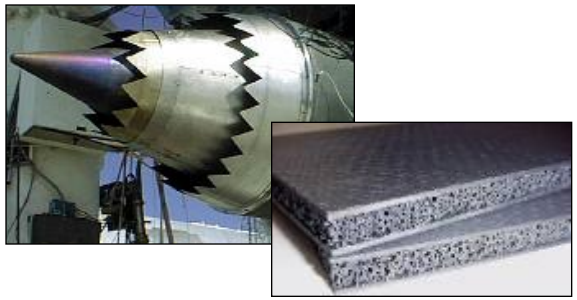


Support to System Development



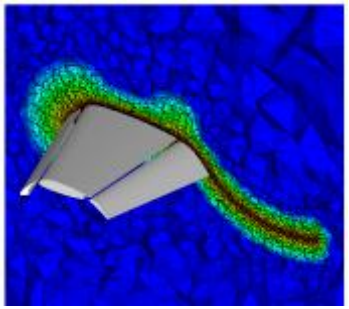


Computational Tools/ Models



Novel Technologies and Materials

Experimental Data



Foundational Research

Operational Concepts

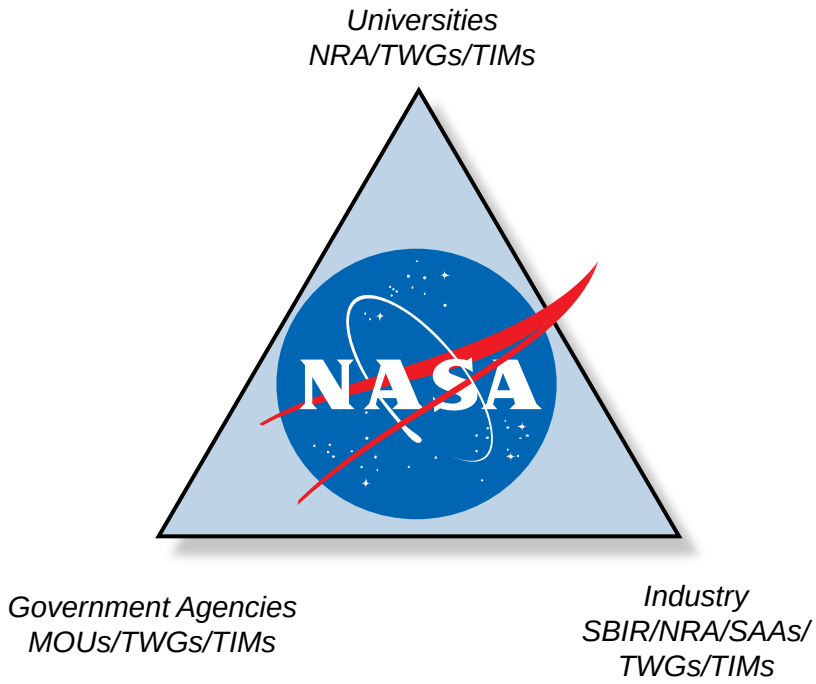
Future Concepts

Experimental Vehicles

Publications and Databases

Partnership Philosophy

- Help foster a collaborative research environment in which ideas and knowledge are exchanged across all communities
- Maximize the return on investment to the taxpayer (our main stakeholder)
- Every element of our portfolio targets innovative, pre-competitive research that will advance our Nation's aeronautical expertise
- In accordance with NASA's Space Act (as amended) and the National Aeronautics R&D Policy, we will provide for the widest practical and appropriate dissemination of our research results (consistent with national security and foreign policy)



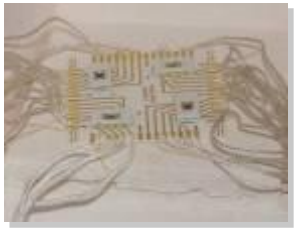
NASA Research Announcements

The Research Opportunities in Aeronautics (ROA) NRA continues to be an extremely successful component of the ARMD research portfolio.

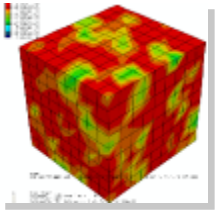
- **NRA is open to academic institutions, industrial organizations, and non-profit organizations**
- **Full and open competition and encourages participation from a broad range of organizations**
  - 138 unique organizations representing 37 different states and the District of Columbia selected for negotiation of award
- **Thorough review process: full and open competition**
- **NRA numbers continue to grow.**
  - Over 1490 proposals received (since July 2006)
  - 385 selections for negotiation of award
  - 374 have been awarded

N+3 Future Systems Study

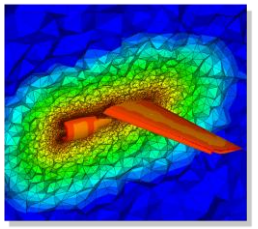
Integration of Advanced Vehicles and Concepts into NextGen Study



Advanced Sensors



Microstructural Finite Element Analysis



Computational Fluid Dynamics

SYSTEM FOCUSED ⟷ **FOUNDATIONAL**

Space Act Agreements

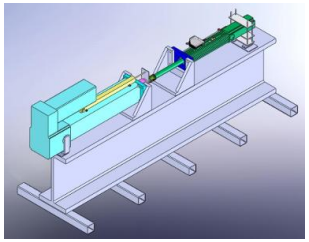
Space Act Agreements (SAAs) continue to be an extremely successful component of the ARMD research portfolio.

- Non-reimbursable cooperative agreements
- Provide opportunities to leverage industry's system-level expertise while facilitating the rapid transfer of knowledge and technology from NASA to industry
- Two rules that we follow:
  - A collaboration is only pursued when there is significant benefit to NASA and its constituencies (the broad aeronautics community, industry, academia, and ultimately, the taxpayer).
  - The results of such a collaboration must be appropriately disseminated and validated through a peer-review process.
- At least 68 SAA's are in place across the programs

GEAE: Open Rotor Fan and Aerodynamic and Acoustic Testing

Boeing and Air Force: X-48B flight testing

Gulfstream: Develop low sonic boom technologies



Moog: Electromechanical Actuators

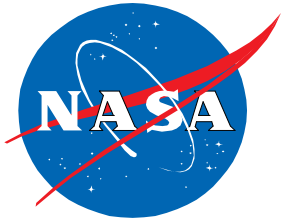
System level ⟷ Component level

Observations

- It is harder to stop something than to start something new – this is needed when budgets are fixed.
- Observed initial reluctance/ resistance to work with outside organizations.
- The definition of “failure” for R&T programs/ projects is not the same as with their flight counterparts.
- ARMD has not been completely successful communicating the purpose and implementation of research milestones, but we are continuing to work on the issue.
  - **Reluctance to set challenging goals**
  - **Fear of “missing a milestone”**

Observations

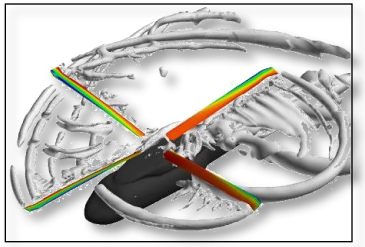
- There is an important distinction between “new” research and “innovative” research.
  - **ARMD is trying to instill the concept that most research in our portfolio should be innovative**
  - **In order to ensure that new concepts can be considered, better processes are needed to bring new ideas and concepts into the portfolio. This may happen in three areas:**
    - New approaches within planned research
    - Bringing new ideas that fit within the existing project structure
    - New ideas that may change the program/ project organization
- Stress the importance of “technical excellence.”
- Consider the impact of improper management practices
  - **Excessive reporting**
  - **Unintended consequences (e.g. improper risk management approaches)**


NASA

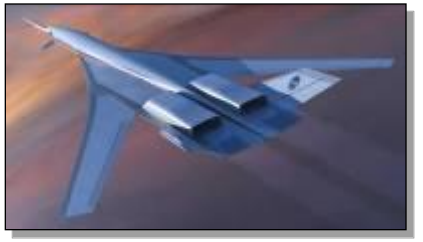
Fundamental Aeronautics Program

Common objectives for all projects: Develop **prediction and analysis tools** for reduced uncertainty in design process and advanced **multidisciplinary design and analysis capability** to guide our research and technology investments and realize integrated technology advances in future aircraft

- ***Subsonic Fixed Wing (SFW)***
  - Develop concepts/technologies for enabling dramatic improvements in *noise, emissions and performance* (fuel burn and reduced field length) characteristics of subsonic/transonic aircraft



- ***Subsonic Rotary Wing (SRW)***
  - Radically Improve capabilities and civil benefits of rotary wing vehicles (vs fixed wing) while maintaining their unique benefits
- ***Supersonics***
  - Eliminate environmental and performance barriers that prevent practical supersonic vehicles (cruise efficiency, noise and emissions, performance)
  - Develop supersonic deceleration technology for Entry, Descent, and Landing into Mars

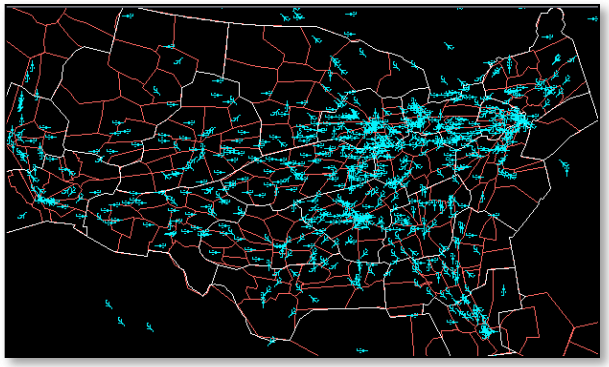


- ***Hypersonics***
  - Conduct fundamental and multidisciplinary research to enable airbreathing access to space and high mass entry into planetary atmospheres

Airspace Systems Program

Common objectives for both projects: Develop and demonstrate future concepts, capabilities, and technologies that will enable major increases in air traffic management effectiveness, flexibility, and efficiency, while maintaining safety, to meet capacity and mobility requirements of the NextGen.

- ***NextGen - Airspace Project***
  - Dynamic Airspace Configuration
  - Traffic Flow Management
  - Separation Assurance
  - Super Density Operations
  - Performance-Based Services
  - Trajectory Prediction, Synthesis & Uncertainty
  - System-Level Design, Analysis & Simulation Tools



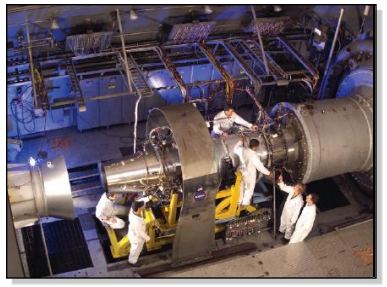
- ***NextGen - Airportal Project***
  - Safe & Efficient Surface Operations
  - Coordinated Arrival/Departure Operations Management
  - Airportal Transition and Integration Management

Aviation Safety Program

Common objectives for all projects: take a proactive approach to safety challenges with new and current vehicles and with operations in the Nation's current and future air transportation system.

- Aircraft Aging and Durability (AAD)
  - Address aging and durability issues in emerging and next generation aero platforms
- Integrated Intelligent Flight Deck (IIFD)
  - Create novel methods of operating flight deck systems, enabled by the rigorous, systematic design of new technologies and operating procedures.
- Integrated Vehicle Health Management (IVHM)
  - Develop validated integrated vehicle health management tools and techniques to enable detection, diagnosis, prognosis, and mitigation of adverse events.
- Integrated Intelligent Flight Deck (IRAC)
  - Develop validated, multidisciplinary integrated aircraft control design tools and techniques for enabling safe flight in the presence of adverse conditions (faults, damage, and/or upsets).

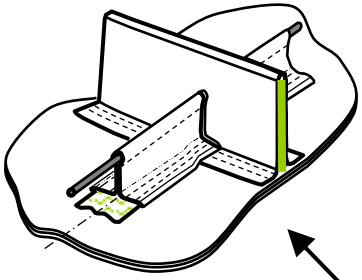
Aeronautics Test Program



Common objectives for all projects: Ensure the strategic availability, accessibility, and capability of a critical suite of aeronautics **ground test facilities** and **flight operations assets** necessary to meet Agency and National aeronautics needs.

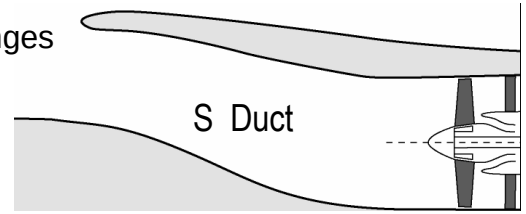
- Ground Test and Flight Operations
  - Implement an investment strategy for NASA owned test capabilities to ensure their long term health and operational availability
  - Provide consistent cost accounting practices, stable pricing policies, and representative performance measurements
  - Divest redundant or under-utilized test facilities and infrastructure
- Maintenance and Upgrades
  - Implement a maintenance and recapitalization strategy for NASA owned test capabilities to ensure their long term health and operational reliability
- Research and Test Technology
  - Develop or enhance facility, system, test, and instrumentation technology so that portfolio test capabilities meet or exceed customer requirements

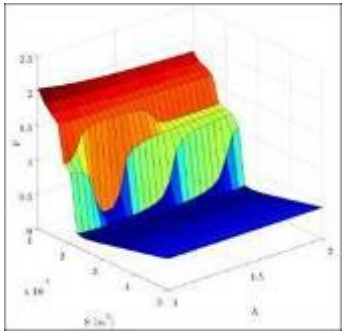
Challenges for Next Generation of Fixed Wing Aircraft Configuration to Meet Aggressive Fuel Burn and Noise Goals



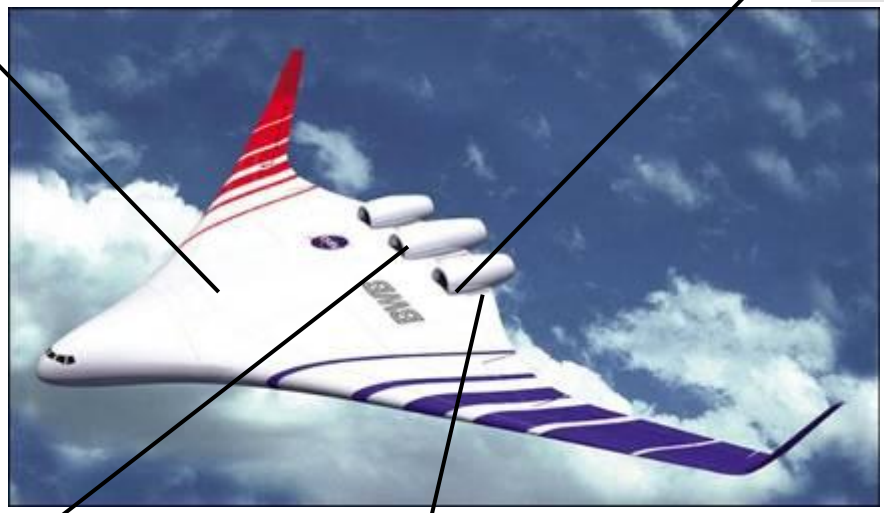
Non-circular pressure vessel requires advanced composite structural concepts to reduce weight

Embedded engine pose inlet and fan operability challenges





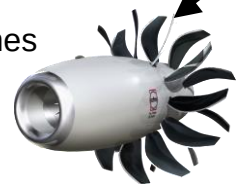
Physics-based Multi-disciplinary design and analysis tools required to design new aircraft configurations



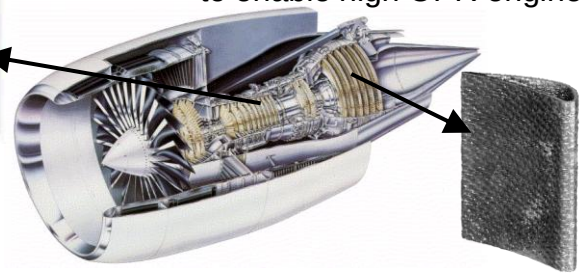
Need smart materials with high temperature capability to reduce weight of variable area nozzle for noise reduction

Materials with higher temperature capability required to enable high OPR engine

Ultra high bypass engines pose unique integration challenges

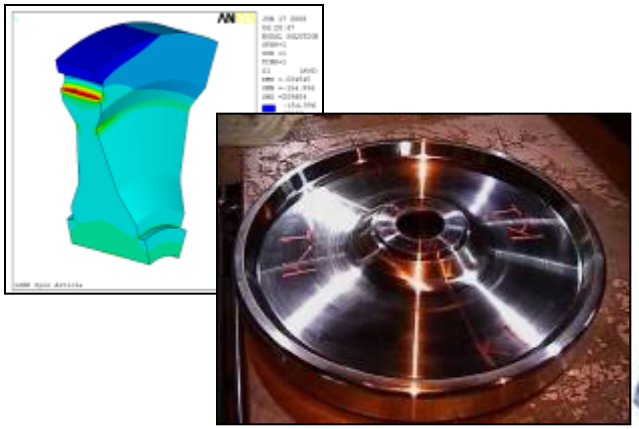


High temp disk

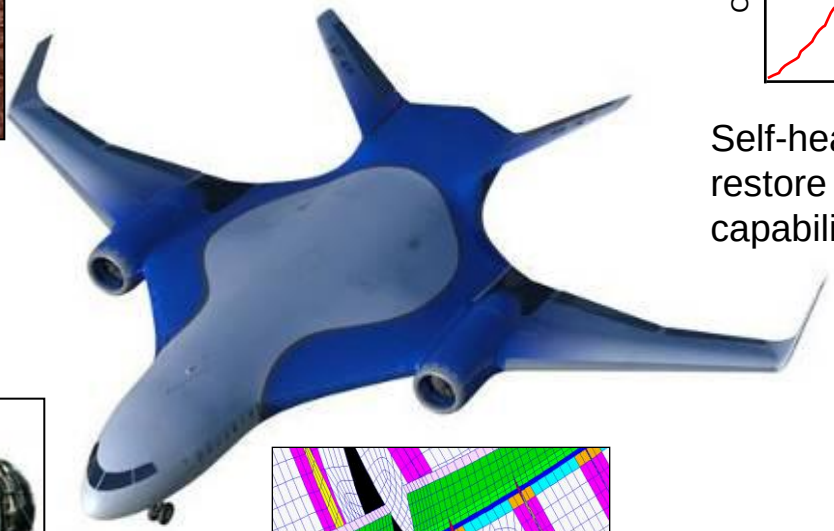


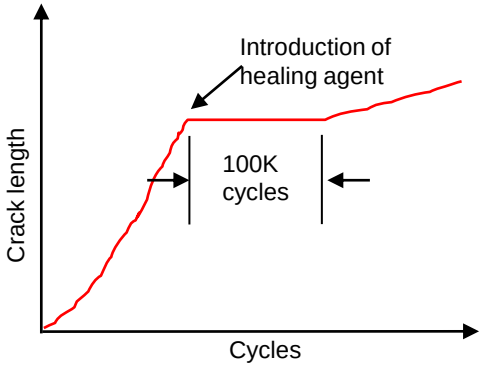
CMC turbine component

Challenges in Vehicle Safety



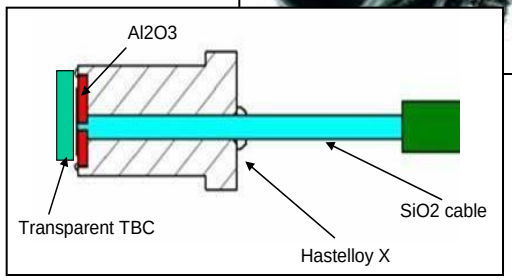
Define operational limits of engine superalloy disks with respect to rim attachment issues

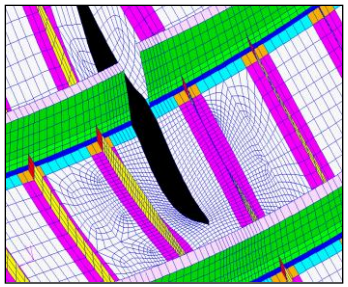




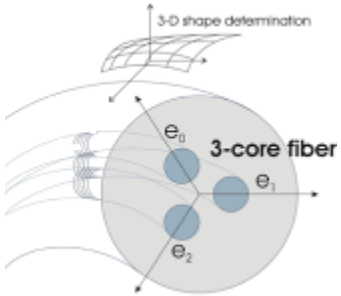
Self-healing material research to restore some or all load-bearing capability of a structure

Propulsion gas path microwave tip clearance sensor development to detect problems with blades



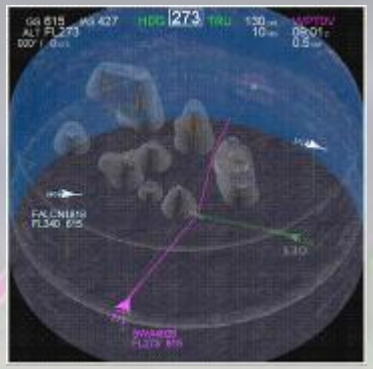


Physics-based analysis tool development to analyze progressive failures of composite materials

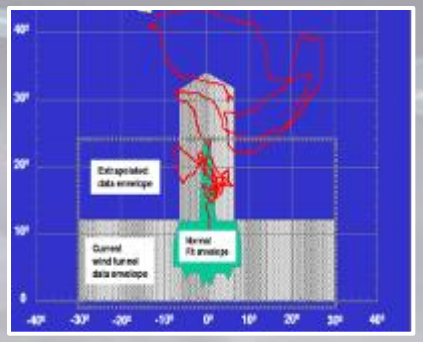


Monitoring of airframe deflections during high load situations such as turbulence and hard landings

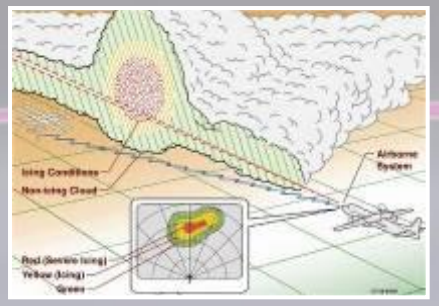
Challenges in National Airspace System Safety



Planning trajectories in real-time



Enabling safe flight in the presence of adverse conditions (faults, damage, and/or upsets).

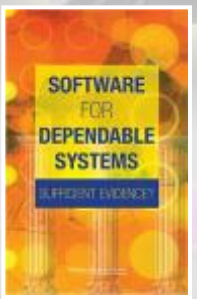


Fine-resolution sensing of hazards

Developing and evaluating complex human-automation systems

Probabilistic analysis of coupled traffic and weather prediction

Data mining of diverse data sets for near-real-time diagnosis & prognosis



Verifying & validating flight-critical systems

NextGen Transformation Challenges

From…	To…
Ground-based Navigation and Surveillance	Satellite-based Navigation and Surveillance
Voice Radio Control	Digital Data Exchange
Disconnected Information Systems	Net-Centric Information Access
Human-centric Air Traffic Control	Automation Assisted Air Traffic Management
Fragmented Weather Forecasting	Probabilistic Weather Decision Tools
Visibility Limited Airfield Parameters	Equivalent Visual Operations
Forensic Safety System	Prognostic Safety System
Inefficient security screening	Integrated Security Risk Management
Current aircraft environmental footprint	Much reduced aircraft environmental footprint